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Data Paper

The Dolichens database: the lichen biota of the Dolomites

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Abstract

The Dolichens project provides the first dynamic inventory of the lichens of the Dolomites (Eastern Alps, Italy). Occurrence records were retrieved from published and grey literature, reviewed herbaria, unpublished records collected by the authors, and new sampling campaigns, covering a period from 1820 to 2022. Currently, the dataset contains 56,251 records, referring to 1,719 infrageneric taxa, reported from 1820 to 2022, from hilly to nival belts, and corresponding to about half of the species known for the whole Alpine chain. Amongst them, 98% are georeferenced, although most of them were georeferenced a posteriori. The dataset is available through the Global Biodiversity Information Facility (GBIF; https://www.gbif.org/es/dataset/cea3ee2c-1ff1-4f8e-bb37-a99600cb4134) and through the Dolichens website (https://italic.units.it/dolichens/). We expect that this open floristic inventory will contribute to tracking the lichen diversity of the Dolomites over the past 200 years, and providing the basis for future taxonomic, biogeographical, and ecological studies.

Key words: Georeferencing, herbarium specimens, historical records, lichen diversity, occurrence, open inventory

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Introduction

The Dolomites, in the Southeastern Italian Alps, were declared a UNESCO World Heritage Site in June 2009, because of the uniqueness of their geology and landscapes. Such a variety of spectacular forms are related to their complex geological origin, as well as to the processes that have modeled the landscape (Messner and Tappeiner 2010). The Dolomites, along with the surrounding areas, constitute a complex mosaic of habitats, which underpin their high biodiversity (Pignatti and Pignatti 2016; Rota et al. 2022).

The Dolomites are one of the lichenologically best-known areas in Italy. Here, lichen diversity is strictly related to the variety of climatic conditions and substrates (Nimis 1993). Trentino-Alto Adige, in particular, is the lichenologically richest administrative region of Italy, with 1,684 infrageneric taxa reported to date, while 1,234 and 1,364 infrageneric taxa are known for the neighboring Veneto and Lombardia regions (Nimis and Martellos 2024).

These comparatively high figures are due to the long tradition of lichenological research in the area, which has been explored since the 19th century. The majority of historical contributions are attributed to Ferdinand Arnold (1828–1901), who surveyed South Tyrol in the last years of the 1800s and published the results in his Lichenologische Ausfluge in Tirol (1868–1897). Another relevant contribution was provided by Ernst Kernstock (1852–1900) in his Lichenologische Beitrage (1890–1896). The lichen records collected in the area until 1901 were summarized by Dalla Torre and Sarnthein (1902) in one of the oldest "checklists". In the first half of the 20th century, these territories were mainly explored by Pio Bolzon (1867–1940) and Maria Cengia Sambo (1888–1939), who published several contributions on local lichen flora (Nimis 1993).

Despite the lichenological relevance of the Dolomites, no modern synthesis of their lichen diversity was ever attempted. There are important resources on the lichens of the Alps (Nimis et al. 2018), and on the lichen biotas of Italian Alpine regions (Martellos et al. 2023), but neither of these resources recognizes the Dolomites as an independent operational geographic unit. In addition, to our knowledge, no geo-referenced occurrence records of lichens are available online for the Dolomites.

Inventories based on new field explorations (Vondrák et al. 2016; Spribille et al. 2020), review of herbarium specimens, and literature records (Isocrono et al. 2007; Himelbrant et al. 2018) provide fundamental information on ecology and distribution of species. Furthermore, they foster taxonomic discoveries, including the description of new species and higher groups (Spribille et al. 2020; Leavitt et al. 2021; Nascimbene et al. 2022). Finally, if occurrence records are geo-referenced, it is possible to perform spatial analyses, such as biogeographical studies or distribution modeling (Bloom et al. 2018; Guttová et al. 2019; Marsico et al. 2020), which are pivotal for revealing biodiversity patterns, predicting potential shifts in a global change scenario and contributing to effective conservation guidelines (Ellis et al. 2007; Eaton et al. 2018; Nelsen and Lumbsch 2020).

The Dolichens project was launched in 2022. It aims at building a dynamic geo-referenced inventory of the lichen biota of the Dolomites by aggregating occurrence records from published and gray literature (such as university research theses), unpublished data, and herbaria from the 19th century onwards. The project aims at aggregating occurrence records from recent surveys as well. The result is a database accessible online (https://italic.units.it/dolichens/), which is continuously updated.

Sampling methods

Description: The Dolichens system hosts georeferenced occurrence records of lichens in the Dolomites, from the 19th century onwards. The geographical delimitation of the Dolomites region was, however, not simple, since several contrasting definitions exist (Bentivoglio and De Simoni 1980; Bosellini 1989; Marazzi 2005; Messner and Tappeiner 2010). In this study, a core area was selected (Fig. 1), which is wider than the most common geographical definition for the Dolomites provided by the Partition of the Alps and the SOIUSA (Marazzi 2005). It spans an area of 11,735 km^2, encompassing the territories surrounding the 9 UNESCO systems (Messner and Tappeiner 2010), thereby incorporating the Friulian and Brenta Dolomites, extending southward to the Venetian and Carnic

Prealps, in order for us to be able to include the area of the “Little Dolomites” (Bosellini 1989) as well. In addition, a buffer area was delimited (Fig. 1), which extends northward and eastward to the national borders, enclosing the Stelvio National Park and the Adamello Brenta Natural Park on the west, and reaching the border of the Po-Valley near Verona, covering a surface of 29,299 km^2. Data aggregation was focused on the core area, while data from the buffer area were aggregated when they were included in the same resource reporting data from the core area. Thus, the Dolichens project provides a preliminary baseline for the development of a future lichen inventory of the Eastern Italian Alps.

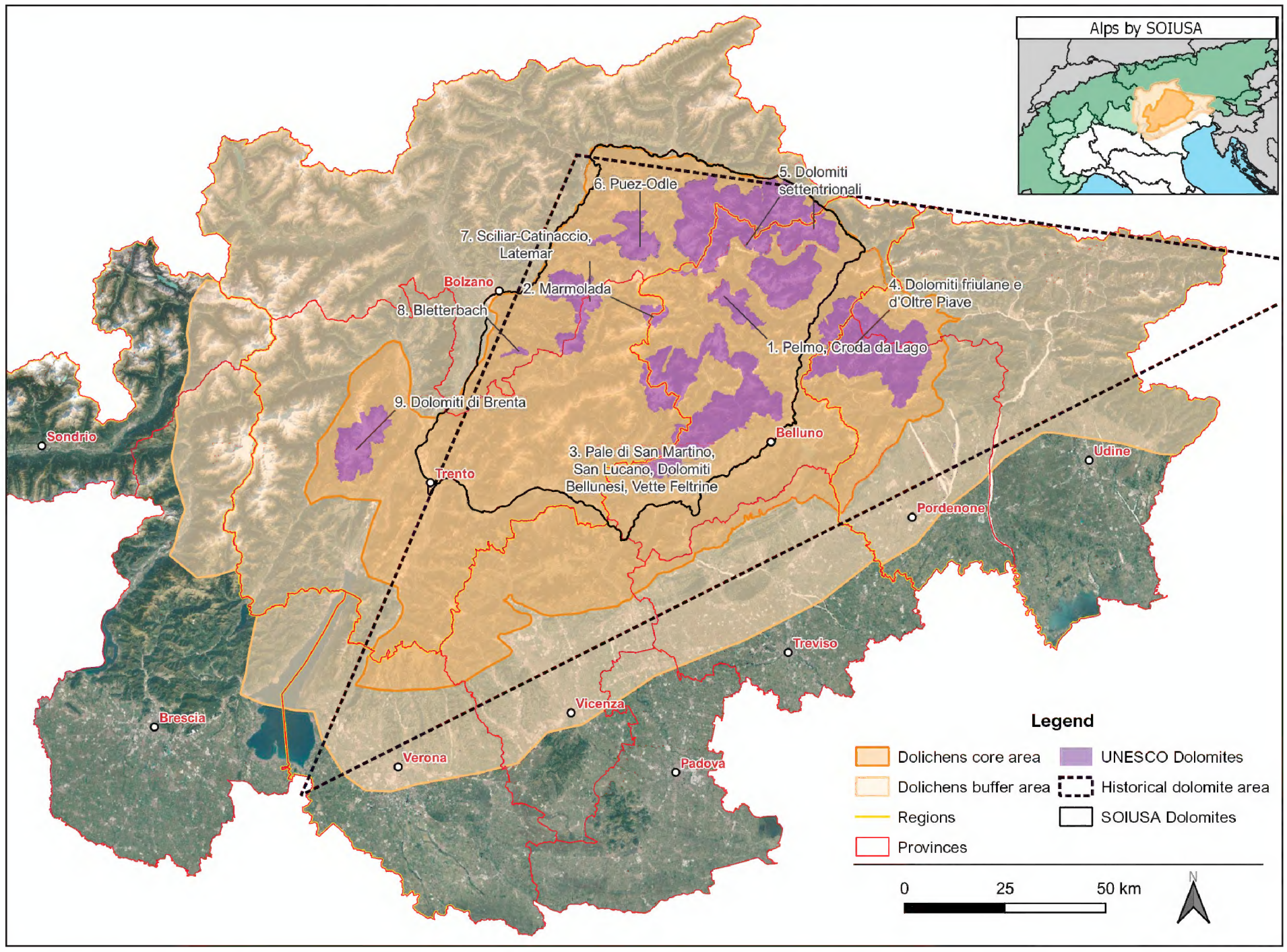

Figure 1. Study area of the project. The core area (dark orange) is wider than the SOIUSA definition (black line, Marazzi 2005). It includes all the 9 UNESCO systems (purple) and it extends southward to the Prealps including the Little Dolomites as well, retracing the historical definition (dotted black line, Bosellini 1989).

Sampling description: For this study occurrence records were collected from different sources. First of all, to compile a baseline inventory of the lichens of the Dolomites, we gathered records from literature starting from the 19th century (such as checklists, vegetation surveys, and taxonomic revisions). Among them, the most exhaustive historical source is the catalogue of Dalla Torre and Sarnthein (1902), from which 10,299 records referring to 885 taxa were retrieved. Furthermore, unpublished records collected by the authors, as well as from gray literature, were gathered. Herbarium specimen data were retrieved from historical herbaria, some of which were reviewed by the authors of this contribution, such as those of Alberto Parolini (1788–1867), Francesco Ambrosi (1821–1897), or

Giacomo Bresadola (1847–1929). Finally, sampling campaigns were carried out and are still ongoing, mainly in the Paneveggio Pale di San Martino Natural Park, the Adamello Brenta Natural Park, and the Dolomiti Bellunesi National Park. They are focused on protected areas and allow the investigation of both historical sites and new locations, which have been poorly explored by lichenologists.

Quality control: Specimens were collected and identified/revised by the experienced lichenologists of our group (e.g. Nascimbene, Nimis) and colleagues from other universities. However, the current database is not a critical checklist. The latter will be developed in the future by critically evaluating all the collected records.

Scientific names were automatically aligned to the latest version of the annotated checklist of Italian lichens (Nimis 2016), available on ITALIC 7.0 (Martellos et al. 2023) by means of a customized version of the FlorItaly name-matching tool (Conti et al. 2021). Then, the scientific names were normalized against the GBIF backbone (GBIF Secretariat 2023). The verbatim names have been always retained together with the currently accepted name.

When geographical coordinates of the collection locality were missing, the records were georeferenced a posteriori using Google Maps, Google Earth, and regional GIS maps, following the best practices proposed by Chapman and Wieczorek (2020).

Geographic coverage

Description: The dataset contains occurrence data of lichens reported for 4 administrative regions and 11 provinces of Italy: Friuli Venezia Giulia (Udine 366 and Pordenone 410), Lombardy (Brescia 11 and Sondrio 2), Trentino Alto Adige (Trento 18,052 and Bolzano 20,543), Veneto (Belluno 14,270, Padova 1, Treviso 779, Verona 106 and Vicenza 325). The distribution of records in the study area is shown in Fig. 2.

Coordinates: 10.2782 and 13.7173 Latitude; 45.3834 and 47.0918 Longitude.

Taxonomic coverage

Description: According to the GBIF Taxonomic Backbone, the dataset comprises taxa from 39 orders, 102 families, and 416 genera.

The following families are represented: Acarosporaceae, Adelococcaceae, Arctomiaceae, Arthoniaceae, Arthopyreniaceae, Arthrorhaphidaceae, Ascodichaenaceae, Baeomycetaceae, Biatorellaceae, Byssolomataceae, Caliciaceae, Candelariaceae, Catillariaceae, Chrysotrichaceae, Cladoniaceae, Coccocarpiaceae, Coenogoniaceae Collemataceae, Coniocybaceae, Cystocoleaceae, Dacampiaceae, Didymellaceae, Elixiaceae, Epigloeaceae, Fuscideaceae, Gomphillaceae, Graphidaceae, Gyalectaceae, Haematommataceae, Helocarpaceae, Hygrophoraceae, Hymeneliaceae, Hysteriaceae, Icmadophilaceae, Lecanographaceae, Lecanoraceae, Lecideaceae, Leprocaulaceae, Lichenotheliaceae, Lichinaceae, Lobariaceae, Lopadiaceae, Malmideaceae, Massalongiaceae, Megasporaceae, Melaspileaceae, Microcaliciaceae, Monoblastiaceae, Mycocaliciaceae, Mycoporaceae, Mycosphaerellaceae, Myriangiaceae, Naetrocymbaceae, Nephromataceae, Ochrolechiaceae, Opegraphaceae, Ophioparmaceae, Pannariaceae, Parmeliaceae, Patellariaceae, Peltigeraceae, Peltulaceae, Pertusariaceae, Phlyctidaceae, Physciaceae, Placynthiaceae, Polycoccaceae, Porinaceae, Porpidiaceae,

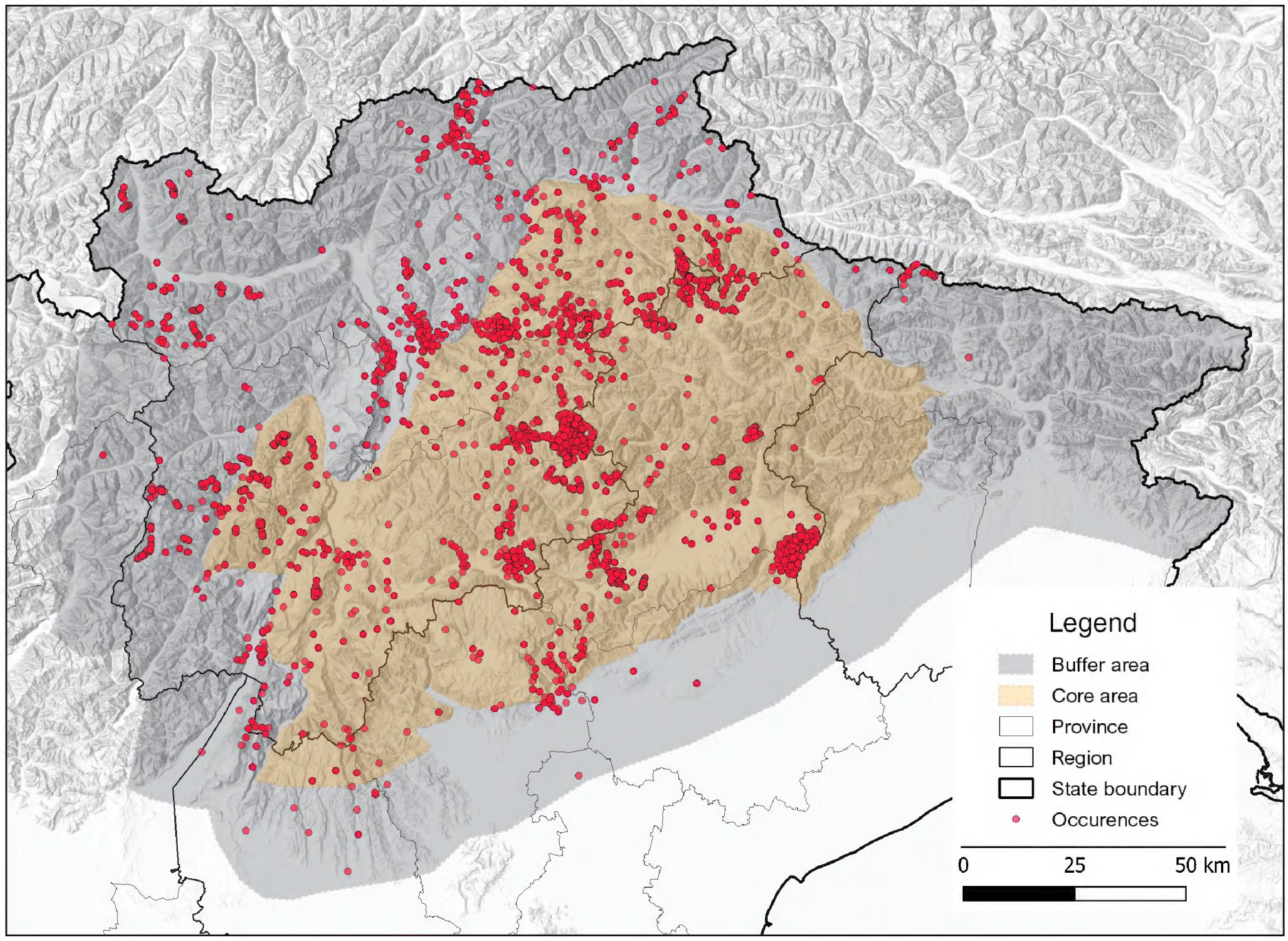

Figure 2. Distribution map of the Dolichens database occurrences and specimens in the study area. Map created using the Free and Open Source QGIS

Psilolechiaceae, Psoraceae, Pycnoraceae, Pyrenulaceae, Ramalinaceae, Ramboldiaceae, Rhizocarpaceae, Roccellaceae, Sagiolechiaceae, Sareaceae, Sarrameanaceae, Schaereriaceae, Sclerococcaceae, Scoliciosporaceae, Sphaerophoraceae, Sphinctrinaceae, Sporastatiaceae, Stereocaulaceae, Stictidaceae, Strangosporaceae, Strigulaceae, Teloschistaceae, Tephromelataceae, Thelenellaceae, Thelocarpaceae, Trapeliaceae, Trypetheliaceae, Umbilicariaceae, Vahliellaceae, Varicellariaceae, Verrucariaceae, Xanthopyreniaceae, and Xylographaceae.

Taxonomic distribution (Fig. 3) and distribution of occurrences (Fig. 4) among each kingdom, phylum, class, order, family, and genus can be graphically visualized as a Krona graph, an interactive multi-layered pie chart that allows the exploration of hierarchical data (the interactive file is provided in Suppl. material 1).

Temporal coverage

Data were reported from 1820 to 2022. Occurrences per year are shown in Fig. 5. The highest number of occurrences in 1902 corresponds to the data retrieved from the most exhaustive historical source, the catalogue of Dalla Torre and Sarnthein (1902), which collects data derived from the publications of previous authors, like Ferdinand Arnold, who explored the Tyrol during the 19th century. Then, the more recent peaks of occurrences from the 1990s correspond to the newfound national interest in lichenology, and the lichenological exploration by the research group of the University of Bologna.

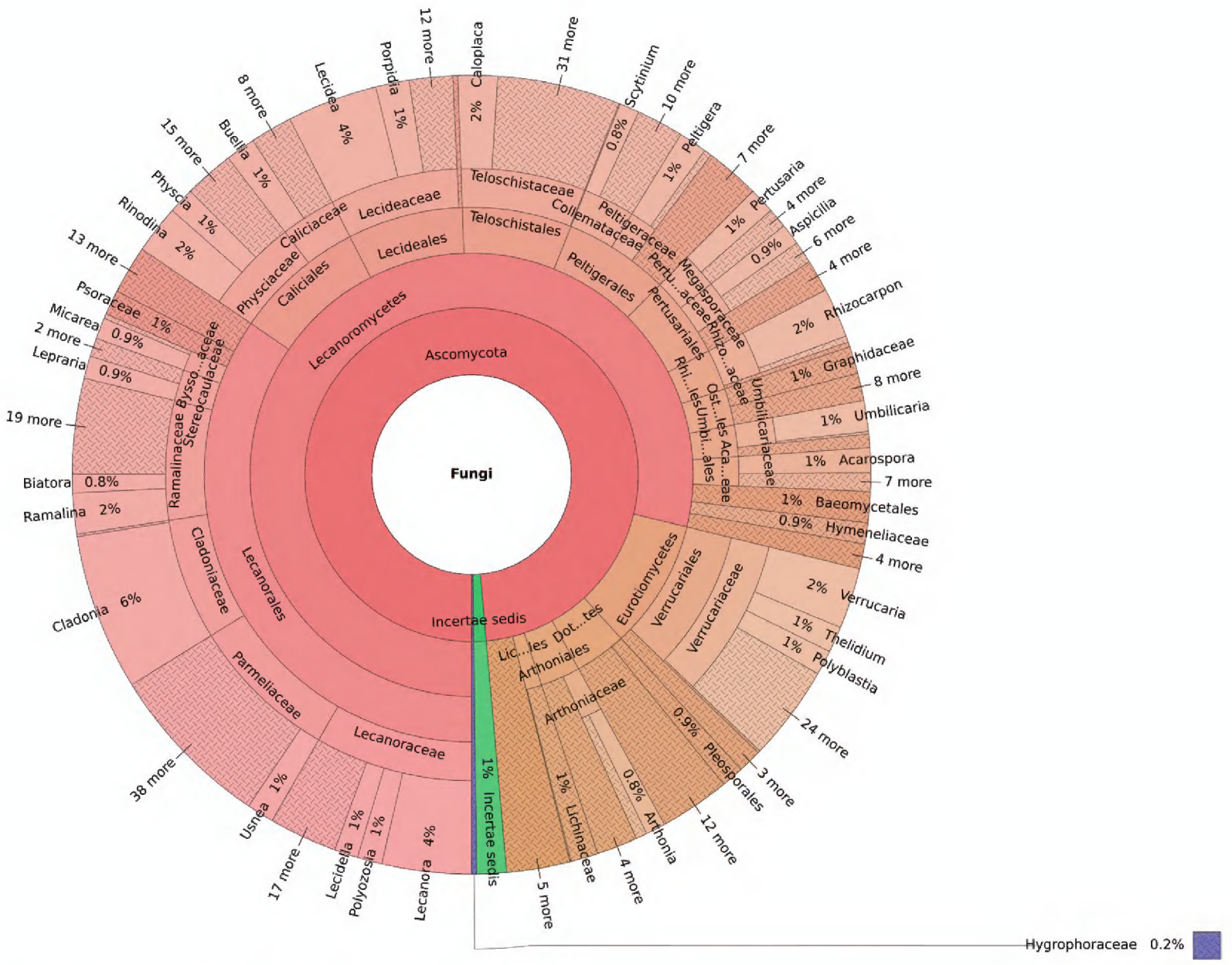

Figure 3. Relative abundance at the genus level referred to the total number of taxa (1994), created using the Krona graph tool (Ondov et al. 2011).

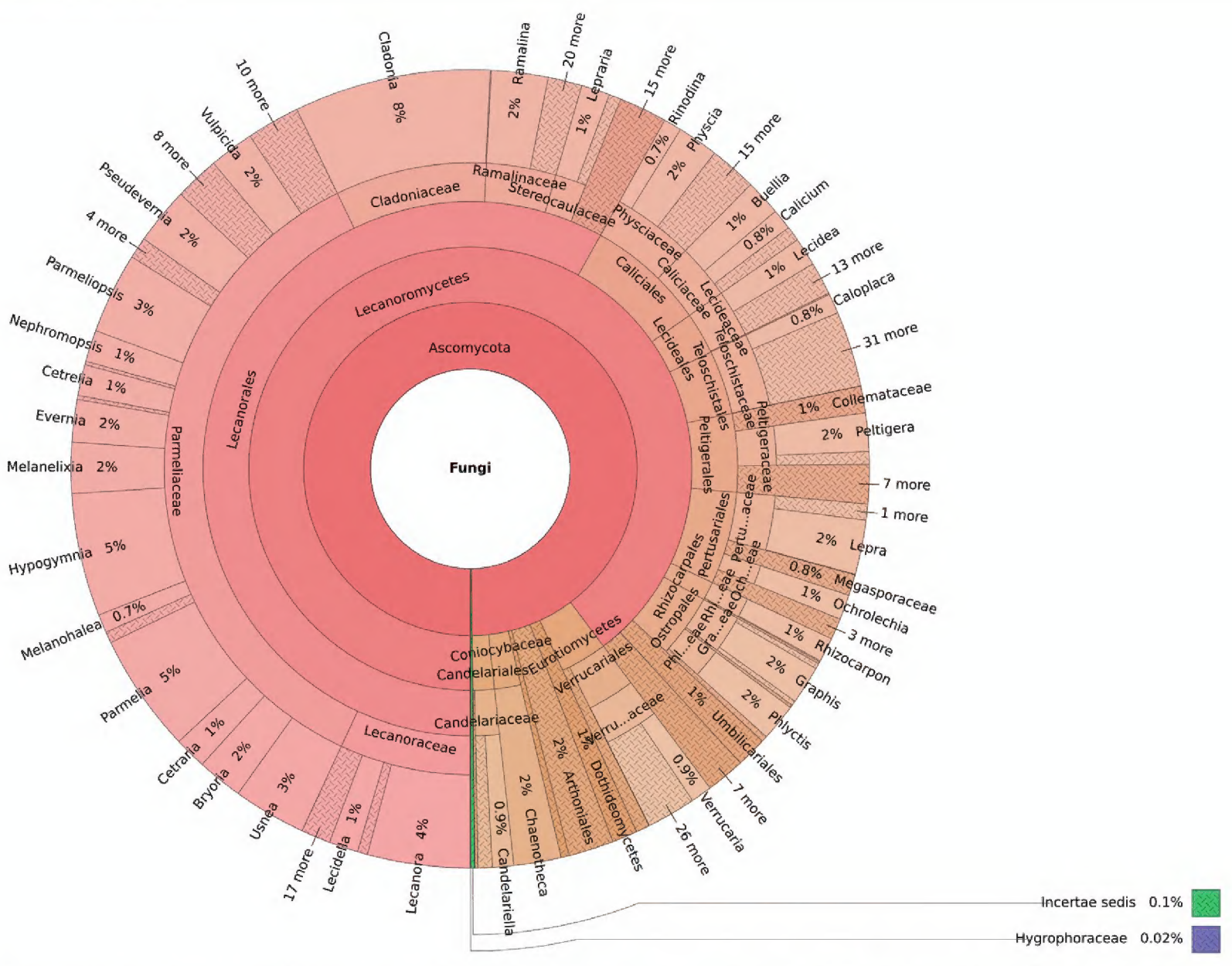

Figure 4. Relative abundance at the genus level referred to the total number of occurrences (56251), created using the Krona graph tool (Ondov et al. 2011).

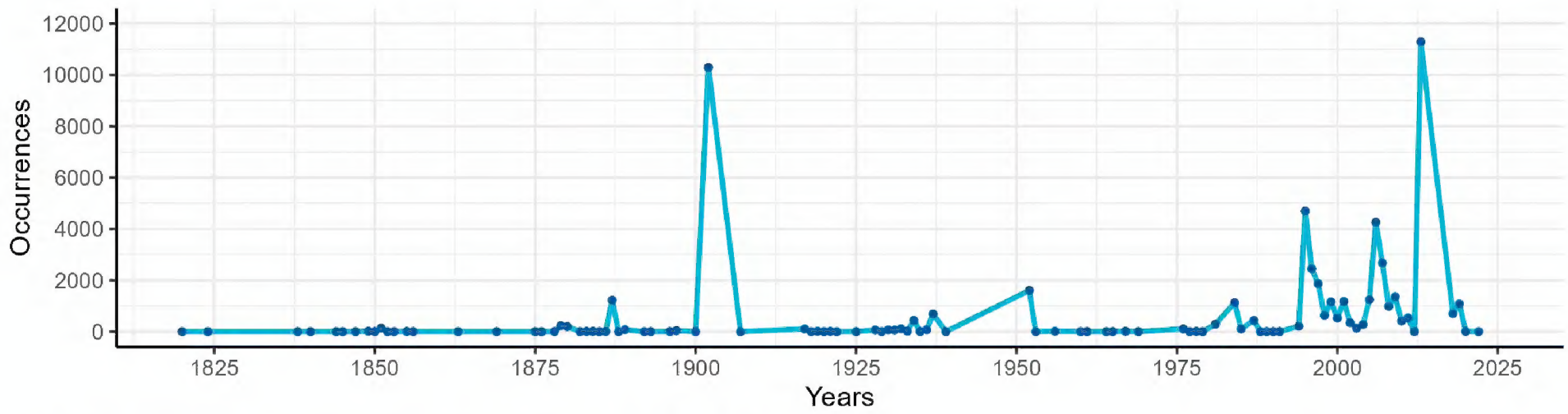

Figure 5. Lichen occurrences of the Dolichens dataset per year.

Usage licence

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Data resources

Data package title: Dolichens project: the lichen biota of the Dolomites.

Resource link: https://doi.org/10.15468/64sy7b.

Alternative identifiers: https://cloud.gbif.org/eca/resource?r=dolichens_project.

Number of data sets: 1.

Data set name: Dolichens project: the lichen biota of the Dolomites.

Download URL: https://www.gbif.org/occurrence/download?dataset_key=-cea3ee2c-1ff1-4f8e-bb37-a99600cb4134.

Data format: Darwin Core.

Description: Launched in 2022 the Dolichens project aims to assemble an inventory of the lichens reported from the Dolomite area since the 19th century. Data of lichen occurrences have been retrieved and aggregated from herbaria, literature, unpublished data, and new sampling campaigns.

Column label	Column description
occurrenceID	A unique identifier for the occurrence.
basisOfRecord	The source or nature of the record.
verbatimIdentification	The original, unaltered identification of the organism.
scientificName	The scientifically accepted name of the organism.
Kingdom	The taxonomic kingdom to which the organism belongs.
eventDate	The date when the occurrence was observed or recorded.
stateProvince	The administrative region in which the organism was recorded.
County	The name of the next smaller administrative region than state Province in which the organism was recorded.
Locality	The location where the organism was observed.
decimalLatitude	The latitude coordinates of the occurrence in decimal format.
decimalLongitude	The longitude coordinates of the occurrence in decimal format.
geodeticDatum	The reference geodetic datum for the coordinate data.
coordinateUncertaintyInMeters	The level of uncertainty associated with the geographic coordinates, in meter
minimumElevationInMeters	The lowest elevation at which the organism was found.
maximumElevationInMeters	The highest elevation at which the organism was found.

Column label	Column description
Continent	The continent where the occurrence was recorded.
Country	The country where the occurrence was recorded.
countryCode	The code of the country where the occurrence was recorded.
recordedBy	The person responsible for recording the occurrence.
identifiedBy	The person responsible for identifying the organism.
associatedReferences	References or sources of information associated with the occurrence.
License	The terms and conditions under which data can be used and shared
Language	The language in which the data or metadata for the occurrence is written

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

No funding was reported.

Author contributions

Conceptualization: JN. Data curation: MC, PLN, LF, GG, JN, CV. Formal analysis: LF, MC. Funding acquisition: JN. Methodology: SM, JN. Project administration: JN. Supervision: SM, JN. Validation: PLN. Visualization: LF. Writing - original draft: MC, LF. Writing - review and editing: CV, JN, SM, LF, GG, PLN, MC.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Krona graph taxa and occurrences

Authors: Luana Francesconi, Matteo Conti

Data type: html

Explanation note: Interactive file of the krona graph, showing relative abundance of the total taxa and the total occurrences in in each class, order, family and genus.

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Link: https://doi.org/10.3897/mycokeys.103.115462.suppl1